THE LONDON UNIVERSITY ELECTION.

SINCE the appearance of last week's NATURE, the course which we ventured to foreshadow in reference to the impending election has fortunately been found practicable. It was announced on the 17th inst. that a committee of graduates unconnected with either of the two party organisations had invited Sir Michael Foster, K.C.B., to contest the seat, and that he had consented to be put in nomination. This fact ought to reassure all those graduates who desired to see the University do itself honour by selecting a fitting successor to Sir John Lubbock. And a passage in Dr. Benson's letter to the *Times* led to a general belief that at least one of the candidates now before the constituency would be willing to retire before a man of really distinguished position and qualifications. Unfortunately, however, it appears that up to the present time neither of them has evinced any readiness to withdraw his personal pretensions.

The only reason assigned by their friends appears to us wholly untenable. They have both presented themselves to the constituency as the special friends of the country graduates. Both of them objected to the report of the Cowper Commission on the ground that in some way or other—not very clearly defined—the interests of the general body of graduates, particularly those who lived at a distance from the metropolis, would be sacrificed to the wishes and the influence of a body of professors connected with the London Colleges. Each of them has secured the adhesion of some of the members of Convocation by conveying the impression that the development of the University, on one of its two sides, as an institution capable of aiding and controlling the higher education of the metropolis, and of bringing the more eminent of the London teachers into vital connection with its governing body, would entail some possible injustice to the older graduates, and cause the value of their degrees to be lowered.

There is not, and never has been, any justification for a fear of this kind. The status of the existing graduates has not been affected, or indeed threatened, by any of the proposals of the Commission or by the subsequent legislation. Nothing has been done to lower the character of the degrees possessed by the present members of Convocation, or to put in peril any of their privileges.

Nor is the principle of external graduation in the future in any way at stake in this election. That principle has been emphatically endorsed in the recommendations of the Royal Commission, constantly restated and enforced in all the resolutions of the Senate as well as of Convocation, and finally safeguarded by the explicit terms of the Act of Parliament. It is difficult to see how a champion of that principle is needed in the House of Commons, or what a member of that House could now do to give to that principle increased strength and permanence.

The fact is that when the statutes of the reconstituted University shall have been framed and have received the Royal Assent, all the controversy which has been rife within the University itself will be at an end. And it is to be observed that in formulating those statutes Sir M. Foster and Mr. Busk have taken an equal share of responsibility, so that both are presumably well equipped with knowledge of the internal constitution of the University and its wants in the future. The domestic politics of the University, even were they far more important than they are, ought not to be uppermost in the consideration of any graduate who has in view the true reputation and influence of his University, and the purpose which ought to be served by the choice of a University member. Ordinary constituencies may be safely trusted to send to Parliament a sufficient number of members who will promise to obey the party Whip, and to look well after local affairs. But the claims of a University to representation rest on other grounds. Such a constituency is bound first to have regard to the national interests in respect to the promotion of learning and science, and to the exposition, when occasion requires, of the views of learned men. A University constituency fails wholly in its duty to the nation if it cannot enrich Parliament by sending to it men of recognised authority and large intellectual influence.

Much stress has been laid upon the voting at recent senatorial elections, as if it furnished a test of the views of the electorate. But any inference thus drawn is wholly unwarranted, and might be seriously misleading. The cases are not parallel. When the graduates are called on to select one of their own number to become one of the Senate, it is reasonable that what are called domestic politics should occupy a large share of attention. For the Senate is the executive body of the University, and is solely concerned with its internal affairs. But when the graduates are invited to choose a *burgess* in Parliament, their responsibility is of a wholly different character, and their choice should be determined by higher, larger, and more permanent considerations. What are the needs of the community in regard to national education, how far it is desirable or possible for the State to supply these needs, what should be the action of the Government in relation to matters in which the interests of science, literature, art, the higher professions, or the encouragement of research are concerned;—all these are grave questions requiring for their solution men of affairs, and of practical knowledge, and of acquaintance with other Universities than their own. And from this point of view it must be evident that the claims of Sir Michael Foster, who, in addition to his other distinctions, is known as a former student and professor in University College, and a graduate of London chosen by Cambridge to become one of its foremost professors, far outweigh the claims of any competitor whose name is before the constituency.

It is important that those members of the University who take this view of the public duty which is cast upon them at the present election will lose no time in making known their willingness to serve on Sir Michael Foster's committee. Pending the publication of a formal address, which is expected to appear immediately, graduates would do well to send in their names to Sir John F. Rotton, 3, The Boltons, S.W.

AMERICAN HIGHER TECHNICAL EDUCATION.

IN dealing with the question of American higher education, we must not lose sight of the fact (due to various causes) that any system of education in a young country like America would probably require certain modifications if adopted in an old world country. The latter would probably be steeped in traditions, many of which are doubtless of great value, yet unsuitable to the requirements of a new country. Americans have derived their fundamental principles of educational methods from us, and have formed them into a system adapted to their special needs. The question which naturally arises, however, after studying the American system, is whether in a modified form it might prove a success in our own country.

In order to more thoroughly understand this system, it will be necessary to explain their methods of working. It is intended to deal only with the course of training undertaken by an engineering student in America, as the same thoroughness characterises the work done by those qualifying for other professions.

The system is nearly the same in all the important American colleges. The student enters at an average age of about nineteen, after passing a severe entrance examination in English, mathematics, and one foreign language. There is at present a strong tendency to raise the standard required for entrance, in order to exclude all but well-trained students.

The length of the course is four years, and comprises mathematics, physics, chemistry, English, French, German, and engineering. The course in pure science is extensive and thorough; chemistry and physics both have fairly extensive laboratory work, while in mathematics the course includes differential and integral calculus, with a small amount of differential equations.

The bulk of the work in pure science is finished by the end of the first two years, the last two years being devoted mainly to professional subjects. The manual training classes or workshops are considered to be one of the most important parts of the engineering course. The reason for the great attention given to practical work is due to the entire absence in America of anything similar to our premium pupilage system. There is no desire to reach the level of hand skill of a good mechanic, the intention being to teach correct methods of using tools, and to show how work should be done.

There are usually four shops through which the student passes in rotation. In the wood shop the course consists of a series of exercises illustrating the use of tools and forms of simple joints; this is followed by a course in wood turning, which naturally leads on to pattern making; fairly complicated patterns are made, such as a spoked wheel, plug cock with the necessary core-box. In the foundry, moulding is taught both in sand and loam, and cores are made and baked by the students; castings are not made from every mould, but only sufficiently often to show the correct methods of working. In the smith's shop there are also a set of exercises on forging, and sometimes the student has to make and harden a complete set of lathe tools for his own use in the turning shop. In the fitting shop the student passes through a course in chipping, filing, scraping, and then goes on to the machine tools, such as the lathe, the milling machine, planer, and shaping machine. The exercises have all been carefully thought out, so that they form a progressive series, each illustrating some principle.

Summer workshop classes of about one month are common, when the students devote their whole time to practical work. During this period the students often undertake to make either the whole of a machine or to finish a previous year's work. At Sibley College they have built wholly in their shops a 60 horse-power triple expansion marine type engine, which is used for experimental purposes; the finish of this engine was quite equal to any ordinary engine, and it was said to run quite as well as any other steam plant.

The shops as a rule are large and well equipped; for instance, there are thirty engine lathes besides other machine tools at Sibley College. One of the most surprising features of their manual training is the amount of hand skill which the student acquires in his comparatively short course; this is, by the Americans, attributed to the fact that their shops are entirely devoted to teaching, and that therefore they can advance the men more rapidly than is possible in a commercial establishment. The question as to whether handicraft is a suitable subject to be taught in a university is too large to be discussed here; but as regards America there can be no doubt of its value, and it is found in every really important engineering course throughout the United States and Canada.

The experimental work in the engineering laboratories is very similar to our own, but everything is on a much larger scale; there are often quite a number of testing machines and experimental engines, each intended to emphasise some special point.

At Sibley College and at Boston there are special engines for teaching valve setting, both for slide valves and Corliss gear. They have at Sibley College a small ammonia refrigerating plant arranged for experiments on the action of inverse heat engines.

MacGill University has a very fine hydraulic plant for studying the laws of flow of water through orifices, pipes and over weirs. The electrical laboratories are large and well equipped; in the dynamo room there are machines of all types for illustrating continuous, alternating and polyphase currents. The supply of testing instruments, such as ammeters, voltmeters, wattmeters, appeared to be on a generous scale.

At several institutions there are full courses for mining engineers, with large laboratories for the reduction of ores to the metallic state, the same type of machinery being used as in a mine. Mining and metallurgy are often taken together; the metallurgy deals principally with copper, lead, silver and gold; the practical work, as regards iron and steel, appeared small when the industrial importance of these metals is considered.

The very large number of students to be found in one college is also significant. Canada is by no means a populous country, yet there are nearly three hundred engineering students at MacGill University, Montreal; and we find from two to five hundred students at all the leading technical institutions; yet in spite of these large numbers, the supply of graduates seems to be unequal to the demand. Almost every graduate can at once obtain a post carrying with it a salary small, but generally sufficient for an independence.

It is difficult for an outside observer to form an absolutely accurate idea of American methods of teaching, but they certainly rely to a greater extent than we do on text-books, and a considerable amount of home work seems to be the rule.

The recitation class, in which students are questioned on the matter of the text-book, is quite unlike anything in England; it is intended to give the teacher a means of discovering what the student knows, and as marks are assigned for success in recitation, it plays an important part in the course. The written examination does not appear to carry the weight that it does with us; no practical or drawing examinations are held, but every piece of work is marked and counts towards graduation.

A special feature is the way in which the purely professional subjects are subdivided. Thus, at Boston, we find no less than seven engineering professors besides assistant professors. There can be no doubt that this specialisation is beneficial to both staff and students. To the staff it must be a great advantage to be able to concentrate themselves on a special subject, which, of course, they can carry further than if they were obliged to cover a wide ground. The subjects of thermodynamics, mechanism, and applied mechanics are really quite separate, although often grouped together under the head of mechanical engineering.

Looking on the system of American technical education as a whole, one cannot but be filled with admiration for the manner in which they have carried out their ideals. Technical education may be looked upon as similar to a manufacturing process; it should turn out a product of the particular kind that is required for the industrial needs of its own country. The actual educational value of the methods of training employed should be subordinated to the commercial question, which is, whether the student obtains that knowledge which will enable him to be of use in industry. In a system of general education the training of the mind is generally taken to be of more importance than the actual knowledge, but professional education stands on a different basis. If this point of view be taken, then the persons who decide on the value of technical education should be the employers into whose service the graduate passes after completing his college course.

American manufacturers who require scientific assistants appear to be perfectly satisfied with the education which is given to the students. In some of the largest works the heads of departments and designers are all college graduates, and in not a few cases important and responsible posts are reached at what seems to us a very youthful age. Part of the success of American manufactures in outside markets is no doubt due to the systematic and thorough technical training of those who direct their manufacture.

The American student works harder than his English confrère, and his work is mapped out for him along strictly utilitarian lines; for the average man the American system is exceedingly good; for the very good man it is doubtful whether it is not too rigid, which may explain why there are so few scholars and brilliant exponents of research produced in proportion to the large number of students. F. W. BURSTALL.

ARMOUR PLATES.

THE different classes of armour which may be used are as follows:—Wrought iron, steel, compound, Harvey, and Krupp types.

Wrought iron was largely used in the first armour-clad battleships, and the late Sir John Brown was practically the first manufacturer of them on a large scale in this country. Owing to its toughness and freedom from cracks under the impact from projectiles, this type held its own for a long time; it could be produced at a fairly cheap rate, and was readily worked into shape. Although attempts were made to employ steel long ago, owing to the higher cost of this material and the methods of fusion not being sufficiently perfected, until comparatively recently, to enable mild or soft steel to be produced—that is, steel low in carbon—this material did not make much way until, in France, methods were introduced of producing at one operation large masses of mild steel.

In this country, however, we branched off into compound plates—that is, plates composed of wrought iron with hard steel faces. There is no doubt, however, that the French policy was the better one, as mild steel plates, though perhaps more easily perforated, do not crack under impact to the same degree as compound plates.

Owing, however, to the enterprise of the American, Harvey, it was found possible to take soft steel plates and carburise them in a similar manner to that which has been used for centuries—that is, carburising by the cementation process (though, of course, Harvey's treatment was necessarily varied to suit the altered nature of the material being treated), so that steel plates were obtained with faces containing considerable percentages of carbon, up to ·70 or ·80 per cent., whilst the rear still retained its original soft and tough condition. Such a plate, after being treated and quenched in water, either wholly or on the hard side, then possessed a very hard surface, against which a shot broke into fragments.

Further improvements were introduced at Krupp's Essen Works, both as regards the composition of the steel used in the plates, a material being obtained of tough nature, yet having great tensile strength with high elastic limit, and also a further improvement was effected by carburising the surface by means of gas cementation instead of charcoal. More regular and uniform results have been thus obtained than by any other process, and though by means of specially shaped projectiles, or projectiles fitted with soft metal caps, such plates can be perforated, this is much more difficult than formerly. Ordinary ogival projectiles without caps go to pieces upon impact, their striking energy being wasted in breaking themselves instead of perforating the plate attacked. Briefly, it may be said that the latest type of hard-faced plates possess about twice the resistance of the older type of plates. This enables a great saving to be effected in the weight of armour to be used for the protection of the modern warship.

My firm has, however, recently produced capped projectiles which, with a slightly higher velocity than the average usually employed, readily perforate hard-faced plates, so that before long we may expect the latest type of plates to be found quite vulnerable. Thus the battle proceeds, first the plate wins, then the projectile, until perhaps some day all civilised nations may find it more profitable to revert to a simpler and more effective method of settling difficulties than by trying to kill each other. R. A. HADFIELD.

NOTES.

EXPRESSIONS of opinion from political leaders as to the value of scientific advice, and the need for scientific methods in Government Departments, are so rare, that some remarks which Lord Rosebery made upon this subject at Chatham on Tuesday come almost as a surprise. We have over and over again referred to the lack of interest in the progress of science, and the disinclination to take advantage of available applications, shown by official authorities concerned with national affairs. Only recently some of the scientific lessons taught by the war have been pointed out in these columns (pp. 37, 83), and some of the services which a committee of men of science could render to the Government if their advice were asked have been indicated. From the subjoined extract from Lord Rosebery's speech it will be seen that he is in accord with the methods advocated in these columns. If the war leads to an acknowledgment of the value of scientific opinion, the result will be one upon which the nation may be sincerely congratulated. The *Times* reports Lord Rosebery to have said:—"We ought to get another great advantage out of this war, for, after all, we in this country have much to learn, and this war will have been a cheap one, whatever it may cost, if it has made us learn several important lessons. I humbly think that in this country we live a great deal too much from hand to mouth. We do not proceed by scientific methods. We go on the principle that things have carried on so well so far, that we are a noble nation, that we are very rich, that we are pretty numerous, and that we have so muddled out right in the end. But I say this, that we are a people of enormous waste. We waste simply by not pursuing scientific methods. I do not like to compare us with Germany. It is hardly safe to mention the name of foreign Powers lest some innuendo be suspected, or else some guilty thought in one's mind. But at any rate we may be certain of this—taking Germany as an example of the opposite method of treatment—Germany is infinitely more painstaking and scientific in its methods than we are. But, without taking as a model Germany or any other country, I believe, if we wish to take full advantage of the lessons of this war after it is concluded, we must become more scientific in our methods in commerce, in education, and in war. We are not methodical, we are not scientific, we are not abreast of the more advanced nations of the day; and if we want to keep our place we shall have to consider the lessons we have been taught in this respect. Depend upon it, however brilliant you may be, the tortoise of investigation, method, and preparation will always catch up and overtake the hare which leaves everything to the inspiration and effort of the moment. Great as the task before us in the field is at this moment, the task that remains for us after this war is completed is the greatest task that ever lay before a nation. You will have, when this war is over, to put your Empire on a business footing. We must have no more discussions as to the way in which one thing has happened to go wrong or has happened to go right. We must consider, deliberately, patiently, and scientifically, the methods by which we have been accustomed to proceed, and